P146 Q41

$$\sum E_i = \sum E_f \qquad W = \Delta E_{nergy}$$

$$E_{g_i} + E_{k_i} = E_{k_f} + W_{friction}$$

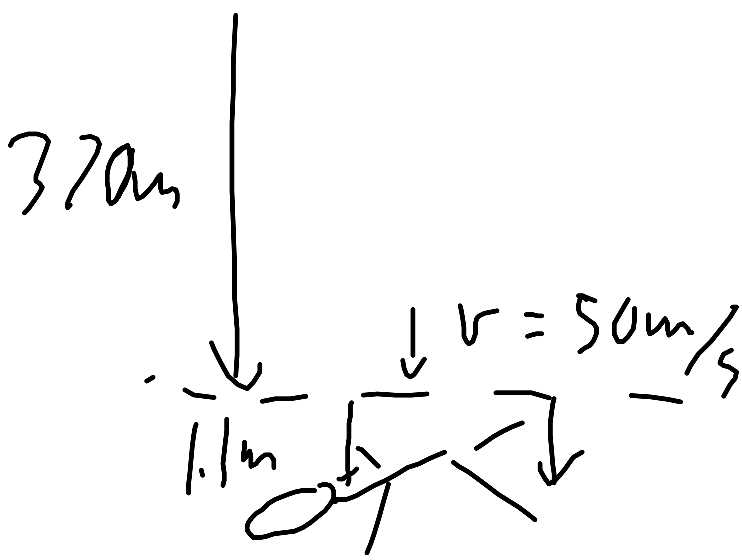
$$mgh_i + \frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 + F_f d$$

$$F_f = \frac{1}{5}mg$$

$$(9.8)(30) + \frac{1}{2}(12)^2 = \frac{1}{2}(v_f)^2 + \frac{1}{5}9.8(6.7m)$$

$$V_f = 18 \text{ m/s}$$

Q25



$W = \Delta Energy = \Delta E_k + \Delta E_g = F_{net} d$

$(F_{up} - F_g)$ ← snow

$\frac{1}{2}mv^2 + mg\Delta h = (F_{snow} - F_g)\,d$

$$\frac{\frac{1}{2}(80)(50)^2 + 80(9.8)(1.1)}{1.1} = F_{snow} - 80(9.8)$$

F_{snow}

40x50x50=100,000
80x9.8x1.1=862.4

a) (100000+862.4)=100862.4
-1.01x10^5J work done = change in energy
negative because 1. force is opposite the displacement 2. energy is lost

b) 100862.4/1.1=91693.0909
80x9.8=784 91693.0909+784=92477.0909
9.25x10^4N up

c) $\sum E_i = \sum E_f$

$E_g = E_k + (E_{lost})$ ← work done by air resistance

$$mgh = \frac{1}{2}mv^2 + E_{lost}$$

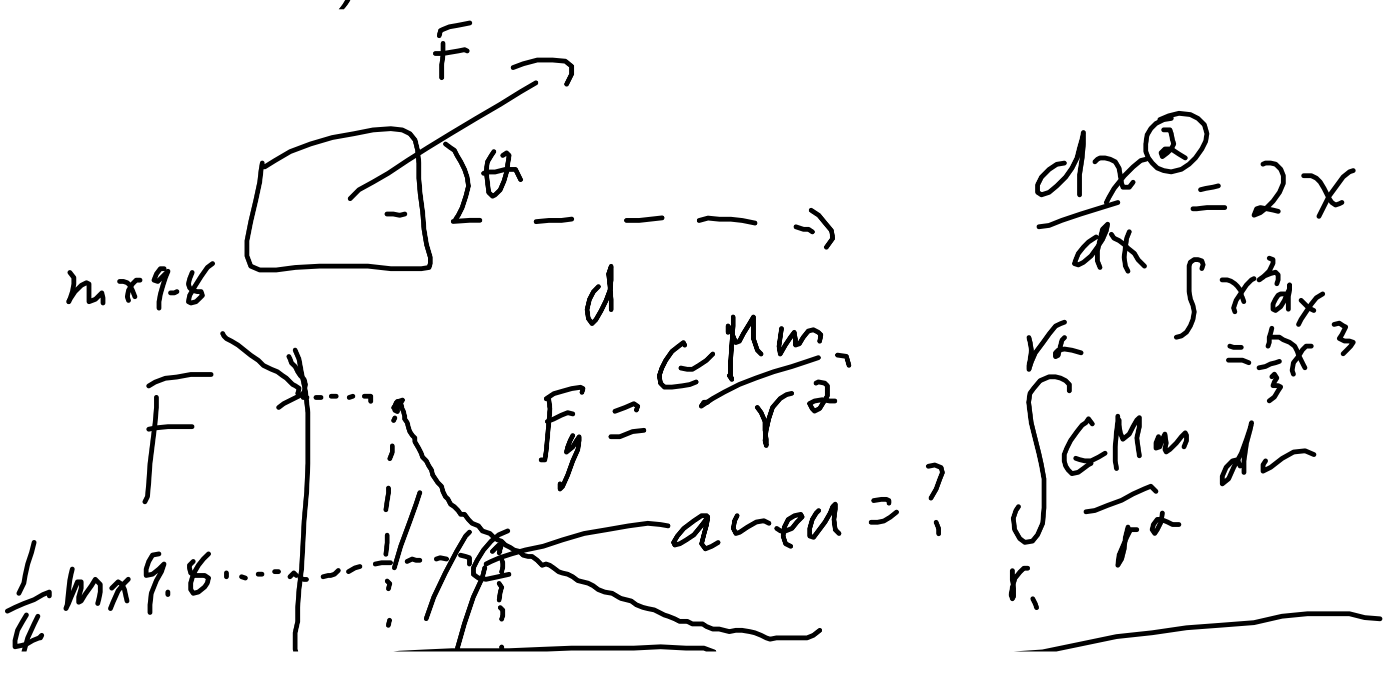
$$80(9.8)(370) = \frac{1}{2}(80)(50)^2 + E_{lost}$$

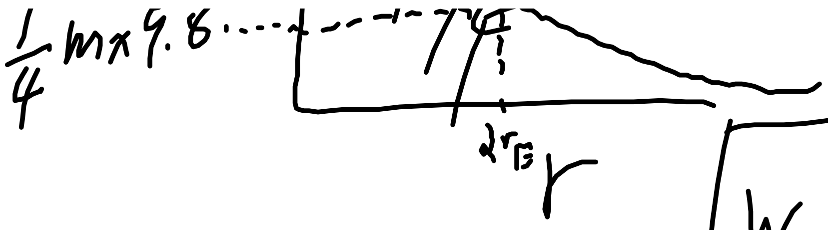
80x9.8x370=290,080 290,080-100000=
190080
W=-1.9x10^{5}J

Universal gravitational Energy - not on quiz not in textbook, I'll give you a handout

Work done against gravity = change in gravitational energy.

Work = change in energy = Fdcosθ if F is constant or = area under the graph - for a curve we use calculus (you don't have to know calculus) but





$$W = -\frac{GmM}{r_2} - \left(-\frac{GMm}{r_1}\right)$$

you can't use r=0 as a reference point.

work = change in energy

E_g = -GMm/r + constant

if we set our reference point where E_g= 0 our constant becomes 0

so we set r= infinity as our reference point

E_g = -GMm/r

A 500.0 kg meteor is moving at 30 000m/s at a height of 20 000 km away.

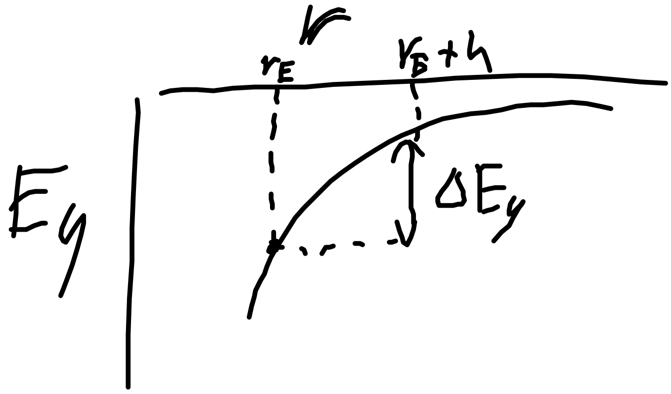
a) what is the gravitational energy of the meteor at that point?
b) What is the gravitational energy when it hits the surface of the Earth?
c) What is the total energy of the meteor?
d) If 90% of the energy is dissipated by the atmosphere, what is the speed of the meteor when it hits the Earth?

Earth mass

a) E_g= -GMm/r = - 6.67x10^{-11}(5.98x10^{24})(500)/(20

000 000 + 6.38x10^{6})
add the radius of the Earth
-7.56 x 10^{9}J

b) E_g= -GMm/r = - 6.67x10^{-11}(5.98x10^{24})(500)/(6.38x10^{6}) =-3.13 x 10^{10}J



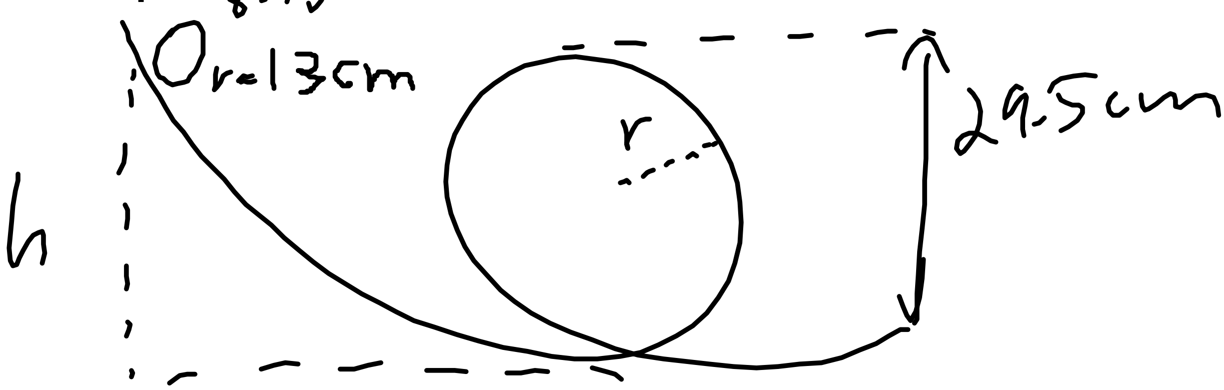
c) Eg + Ek = energy total
-7.56 x 10^{9}J +

0.5x(500)x(30000)x(30000)=2.2E11
2.2E11-7.56E9=2.1244E11
+2.12x10^{11}J

d) 0.1x2.1244E11=2.1244E10
Et= Eg+Ek
Ek = Et-Eg = 2.1244E10-(-3.13E10)=
5.2544E10 =1/2mv^{2}
v = Sqrt(2x5.2544E10/500)=
14,497.4480512951
14 km/s

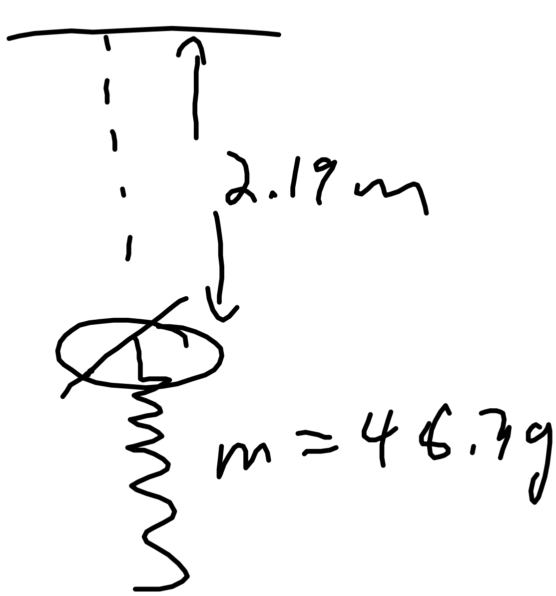
a) What is the lowest height you can drop a toy car or marble so that it can make a loop de

loop?



a) what is the acceleration of the car at the bottom of the loop, in gs?

1. Pull a spring down and let it spring up to the ceiling. How far should you pull it down so that it just touches the ceiling?

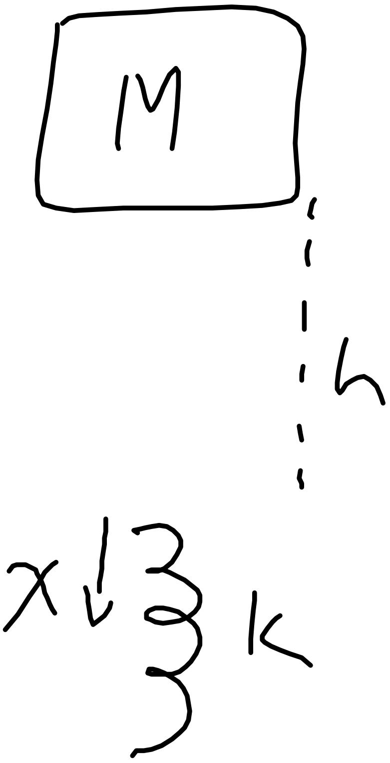


F=4N 6cm
8N 14cm
12N 23cm

Block 2-4
Homework questions
Notes: universal gravitational energy

contest - loop and spring

p146
q65



$a = 5g = \frac{F_{net}}{m}$

$v = 0$

Q25 forgets

$5g = \frac{F_e - F_g}{m}$

$\sum E_i = \sum E_f$

$5mg = F_e - mg$

$mg(h + x) = \frac{1}{2}kx^2$

$F_e = 6mg = kx$

$x = \frac{6mg}{k}$

$mgh + mg\left(\frac{6mg}{k}\right) = \frac{1}{2}k\left(\frac{6mg}{k}\right)^2$

$hk + k\,6mg = \frac{1}{2}k\,36mg$

$hk + 6mg = 18mg$

$hk = 12mg$

$$\boxed{k = \frac{12mg}{h}}$$

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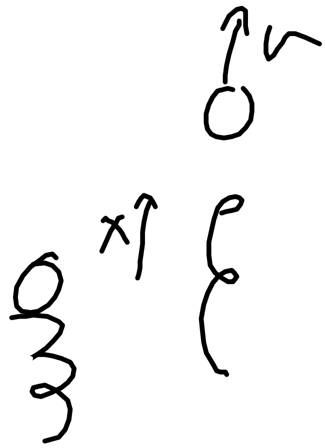


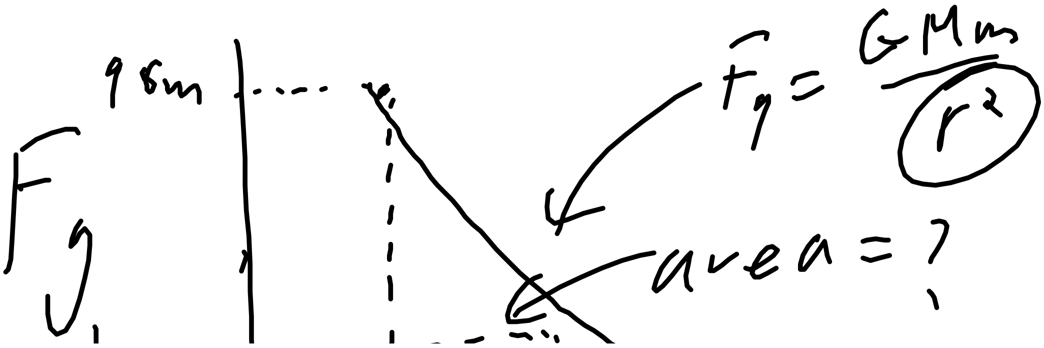
$E_{elastic} = E_k + E_g$

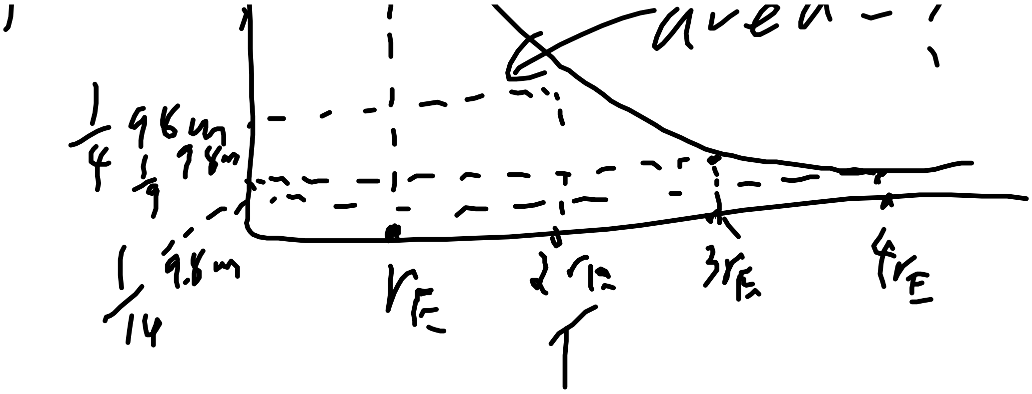
$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 + mgx$

Universal Gravitational Energy (not in book, not on quiz next class)

change in gravitational energy is the work done against gravity

W=Fdcosθ if F is constant otherwise W = change in energy = area under the F-d graph





calculus $\frac{dx^3}{dx} = 3x^2$ (3−1)

$\int x^2 dx = \frac{1}{3}x^3$

$$W_g = \int_{r_1}^{r_2} F_g \, dr = GMm \int_{r_1}^{r_2} \frac{1}{r^2} dr =$$

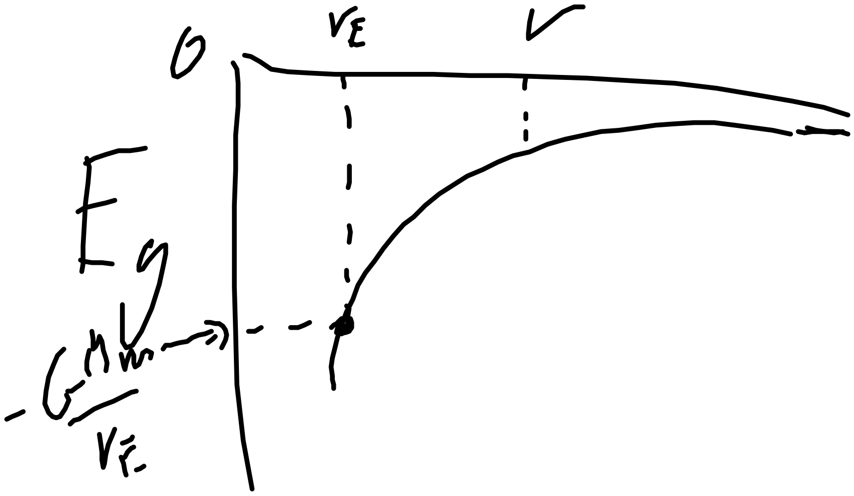
$$-\frac{GMm}{r_2} - \left(-\frac{GMm}{r_1}\right) = W = \Delta E_g$$

$$E_g = -\frac{GMm}{r} + \text{constant}$$

E_g approaches zero when r approaches infinity, so we use that as our reference point so we set the constant to 0.

$E_g = -GMm/r$ relative to 0 at infinity

$E_g = -GMm/r$ relative to 0 at infinity



1. A 2.0 kg meteor is moving at 300.0 m/s relative to the Earth at a height of 20 000 km above the Earth's surface and it falls to Earth.

a) What is the gravitational energy of the meteor initially and at the surface of the Earth(NOT 0)

$E_g=-GMm/r$

= -6.67E-11x5.98E24x2/(26.38E6)=-3.0240E7

-3.02×10^7J is gravitational energy at that height

$E_g=-GMm/r$

= -6.67E-11x5.98E24x2/(6.38E6)=-1.2504E8

= -1.3×10^8 J at the surface (NOT 0)

b) What is the change in gravitational energy? Work done by gravity?

$E_{gf}-E_{gi}=W_g = \Delta E_g$

-1.2504E8-(-3.0240E7)=-94,800,000

-9.48×10^7J

work done by gravity = $+9.48 \times 10^7$J

c) What is the total energy of the meteor?

$E_{total} = E_g + E_k$ = -3.0240E7
+(0.5x2x300x300)=-30,150,000
-3.0x10^7J

d) if 90% of the total change in energy is lost as drag in the atmosphere, what is the meteor's velocity when it strikes the Earth.

Mass of the Earth = 5.98x10^{24}kg
radius = 6.38x10^6m
94,800,000+(0.5x2x300x300)=94,890,000
0.1x94,890,000=9,489,000 J left
1/2 mv^2 = Eleft

$$E_{ti} = E_{tf}$$

$$E_{gi} + E_{ki} = E_{gf} + E_{kf}$$

$$(E_{gi} - E_{gf}) + E_{ki} = E_{kf}$$

v = Sqrt(9489000x2/2)=
3080.422049005623
3.1 x 10^3m/s